valleys or lowlands, therefore the records of rainfall represent the valleys and not the hilltops. This is a very serious matter in mountainous countries, and especially in those portions of the United States where it is important to know the quantity of water available for irrigation.

Mr. F. H. Brandenburg, of Denver, has labored with great success to overcome this difficulty in Colorado. By his unceasing efforts he has secured a large number of rain and snow observations at high altitudes where the rainfall is many times as great as in the valleys. It is now necessary to make a special effort of similar nature with reference to California, Arizona, and New Mexico, and, in general, for the whole arid and Plateau regions. Cases have occurred in western Montana, where the flow of water from a small stream was two or three times as great as the rainfall on its watershed, so far as that could be inferred from a few rainfall stations in the lower valley. Evidently these latter gave no idea whatever as to the rain and snow on mountain tops, from which the river derived its great excess of water. There can be no proper determination of the amount of water available for irrigation, and no explanation of the variable heights of water in the rivers unless we have a sufficient number of gages at high and low stations. Every opportunity to secure a new rainfall observer should be gladly embraced.

PHYSICS AND METEOROLOGY IN THE UNIVERSITIES.

The progress of meteorology depends not merely upon the observer and the compiler of daily weather maps, but more than anything else upon the education of the physicists who are attracted to this branch of science. The study of physics embraces every detail of the many ways in which force acts upon matter. The study of heat, light, or electricity, is the study of the phenomena that are manifested when molecules and atoms interact upon each other. The study of projectiles, the flow of water in the rivers, the motions of the atmosphere, or the tides of the ocean is the study of the action of larger masses of matter under the influence of such forces as the attraction of gravitation, the repulsion due to heat, the centrifugal force due to inertia. We may experiment upon small quantities of air and aqueous vapor in the physical laboratory, and thus learn some of the details as to the physical properties of the atmosphere; but the meteorological phenomena on a large scale can only be studied by means of the daily weather map and with the help of mathematical formulæ, or equivalent graphic methods peculiar to hydrodynamics and thermodynamics. It is evident, therefore, that important progress in meteorology is not to be hoped for from those who only frame hypotheses and speculations as to possible laws that may control atmospheric phenomena. Such hypotheses are often important; it is well said that even the clear statement of a difficulty, or of a problem, is already a long step toward its solution. But the solution is the final step that meteorology demands, and the one that is absolutely essential in order that we may really make true progress. Meteorology presents many unsolved problems, and many more will be recognized as time goes on. The successive steps involved in resolving these problems usually consist of (1) a series of successive hypotheses; (2) the testing of each hypothesis by comparison with observation and the laws of physics; (3) the modification of the hypotheses until we attain one that harmonizes with all that is known on the subject. This process involves a training in mathematics and physical experimentation, and a development of an insight into the ways of nature that does not come naturally to every one. Sir Isaac Newton is an example of those who, by persistent thought and carefully checking every step by comparison with nature, at last penetrate into some of nature's secrets.

Most of us must be content to be good observers, computers, and workers. A few may become bold and successful forecasters, but it is not likely that important additions to our knowledge of fundamental points in meteorology will be made by any except those who have gone through a severe training in the physical laboratories and methods of original research. Therefore, those interested in the progress of our science must look about with some solicitude inquiring what is being done in our American universities to turn the thoughts of earnest students toward meteorology as a branch of physics. Universities are distinguished from colleges in that they offer young men and women special opportunities for original research. They do not usually confer the degree of doctor of physics (Ph.D.) or doctor of science until the student has prepared one or more papers based on his own studies and work, and containing some substantial additions to our knowledge. A slight examination of the titles of these theses during the past few years shows that scarcely one has taken for his subject any problem that is strictly meteorological. This is probably not due to a want of interest in our science on the part of the student or the general public, but may often be traced back to the teacher himself. The universities generally prefer to consider meteorology as a rather insignificant division of the physical sciences; some of them class it with astronomy, others with geography, but in general none of them give it any prominence in the curriculum of studies, or have any special conveniences for instruction therein.

As many of our readers are turning their attention strongly toward meteorology, and inquiring as to courses of study and the attainment of the post graduate degree of Ph. D. in this science, we recommend them to examine the "Graduate Handbook" for 1899, which is published by the Federation of Graduate Clubs, and is intended to show the present condition of graduate instruction.

THE CLIMATE AND CROP SERVICE IN PORTO RICO.

The Porto Rico Section of the Climate and Crop Service of the Weather Bureau was established in the summer of 1898, and its publications have hitherto consisted of weekly bulletins, showing especially the condition of the crops. It was, of course, very desirable that the monthly reports of this section should be printed in quarto form, conformably to the general plan of publication adopted for all of the forty-five sections of this service. But both the difficulty and the expense of such a publication in Spanish and English have hitherto stood in the way, and at first it did not seem possible to overcome these. But now an arrangement has been made by which the composition, chalk-plate work, and printing are done by Mr. E. A. Evans, Section Director at Richmond, Va., while the manuscript is supplied by Mr. R. M. Geddings, the Section Director at San Juan. It is, therefore, to the cooperation of these two directors and to their proverbial enthusiasm that we owe the publication of the report of the Porto Rico Section for May, 1899, as Volume I, No. 1 of the series. Possibly, the report for December, 1899, may be followed by a summary of the whole year so complete as to represent all that the Weather Bureau has done since the summer of 1898.

This first number gives, as usual, full page sketch maps of Porto Rico, with the mean monthly temperature, wind, and rainfall for May, 1899. The isotherm of 80° F. probably skirts the greater part of the southern and northern coast lines; it cuts off a small portion of the eastern end of the island and a much larger portion of the western end. A small area of mean temperature of 82° F. exists in the south-

western corner, but, doubtless, the 80° isotherm will again be found just off the coast. Within this large area of 80°, the mean temperature diminishes to 74° or less as we ascend into the mountainous interior. It is doubtless owing to the prevailing northeast winds that the small region of 82° lies southwest, viz, to leeward, of the mountainous region. The winds and mountains also control the distribution of rainfall. The regions of small rainfall are two, viz, (1) in the southwest, where high temperature, minimum cloudiness, and descending winds prevail; (2) in the east where the northeast trade, after rising over the hills of Humacao and San Juan de Porto Rico, descend into Cayey and the valley of the Loiza, giving light rains and little cloudiness for a small portion of that region. The region of heaviest rainfall extended from western Ponce to the northern coast; the rainfall was also large at the extreme northeastern and northwestern corners.

The only stations for which the average rainfall is known so as to admit of comparisons are San Juan, Luquillo, and Mount Yunki, all three of which report less this year than the normal values. The greatest amount recorded anywhere was 11.36 inches at La Isolina. On the average of 11 stations, there were 14 clear days, 10 partly cloudy, and 7 cloudy days. The number of rainy days varied from 3, in the district of San German, to 11 or 12 in Arecibo and 19 or 20 at Luquillo and Mount Yunki, both in Humacao.

It is evident that about twice as many meteorological stations at carefully selected locations are still needed in order to better represent the distribution of rainfall. As the total area of the island is about 3,750 square miles, and its surface is very much diversified by hills and valleys, the 34 stations already established can only be considered as the first step toward the investigation of the many peculiarities of climate and the discovery of innumerable small regions adapted to the cultivation of special crops.

Mr. Geddings has not only published his meteorological text in both Spanish and English, but has added, in both languages, an excellent article on coffee cultivation by Capt. A. C. Hansard, of Luquillo, which will be helpful to any who may think of undertaking a plantation in Porto Rico.

THE WEATHER OF THE MONTH.

By ALFRED J. HENRY, Chief of Division of Records and Meteorological Data.

PRESSURE.

Atmospheric pressure was considerably higher than usual over all districts save the southern Plateau and the upper Missouri Valley. As compared with the preceding month pressure rose over the region extending from the Lakes and lower Missouri Valley southward to the Gulf and Mexican frontier, and fell along the northern boundary from the headwaters of the Missouri eastward to the mouth of the St. Lawrence. Pressure also fell markedly in California, Nevada, and Arizona.

TEMPERATURE OF THE AIR.

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England	10	65.3	+ 2.1	+ 1.0	+ 0.2
Middle Atlantic	12	72.7	+ 1.8	− 2.0	− 0.3
South Atlantic	10	78.6	+ 1.5	− 1.8	− 0.3
Florida Peninsula	7	80.4	+ 0.6	+ 1.0	+ 0.2
East Gulf	7	80.0	+ 1.1	− 5.6	− 0.9
West Gulf	7	79.3	+ 0.3	− 6.0	− 1.0
Ohio Valley and Tennessee	12	75.5	+ 1.5	− 4.2	− 0.7
Lower Lake	8	68.3	+ 1.3	+ 1.3	+ 0.2
Upper Lake	9	63.3	+ 0.9	− 5.1	− 0.8
North Dakota	7	63.2	− 1.7	−19.2	− 3.2
Upper Mississippi	11	72.3	+ 1.1	− 9.3	− 1.6
Missouri Valley	10	71.6	+ 0.6	−12.0	− 2.0
Northern Slope	7	61.7	− 1.1	−24.3	− 4.0
Middle Slope	6	72.0	+ 0.4	−10.6	− 1.8
Southern Slope	6	61.9	− 1.7	− 0.5	− 0.1
Southern Plateau	13	76.1	− 1.7	− 5.1	− 0.8
Middle Plateau	9	64.2	− 0.6	− 9.3	− 1.2
Northern Plateau	10	59.5	− 2.0	−11.8	− 2.0
North Pacific	9	55.2	− 2.6	−11.2	− 1.9
Middle Pacific	5	62.0	+ 0.1	− 1.2	− 0.2
South Pacific	4	66.8	+ 0.2	− 1.5	− 0.2

The month was slightly cooler than usual in parts of the upper Lake region and generally throughout the Rocky Mountain and Plateau districts. It was warmer than usual in the great Valley of California, and generally east of the Mississippi River. Maximum temperatures of 100° and over occurred in the interior of the South Atlantic States, the Rio Grande Valley, and on the plains northward along the one hundredth meridian. Maximum temperatures ranging from 100° to 120° occurred throughout the desert regions of southern California, in Arizona and southern Utah.

In many localities the minimum temperatures of the month were remarkably low. Light to killing frosts were of frequent occurrence on the higher levels of Oregon, Idaho, Montana, Wyoming, and Colorado. Killing frosts occurred in parts of Hardin, Marion, and Allen counties, Ohio, on the morning of the 30th.

In Canada.—Professor Stupart says:

In no part of the Dominion did the mean temperature differ much from the average. The greatest departure was in Assiniboia and Alberta, where it was 3° to 4° below, and the greatest departure above was in various small districts in the vicinity of Lakes Huron, Erie, and Ontario, where it was about 3°. In Manitoba, Quebec, and the Maritime Provinces, the temperature was either just normal or a little above.

PRECIPITATION.

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		*Inches.*	*Inches.*
New England	10	2.46	83	−0.5	−0.7
Middle Atlantic	12	2.64	73	−1.0	−1.5
South Atlantic	10	3.36	65	−1.8	−2.6
Florida Peninsula	7	5.48	80	−1.4	−1.2
East Gulf	7	4.29	84	−0.8	−7.8
West Gulf	7	4.19	108	+0.3	−4.1
Ohio Valley and Tennessee	12	2.73	65	−1.5	−1.7
Lower Lake	8	1.79	50	−1.8	−2.4
Upper Lake	9	3.92	105	+0.2	−1.7
North Dakota	7	3.94	100	0.0	−0.5
Upper Mississippi Valley	11	4.78	104	+0.2	+1.4
Missouri Valley	10	4.51	102	+0.1	−1.8
Northern Slope	7	1.65	62	−1.0	0.0
Middle Slope	6	5.16	163	+2.0	+0.4
Southern Slope	6	5.61	160	+2.1	+0.8
Southern Plateau	9	0.63	147	+0.2	−1.7
Middle Plateau	13	0.78	162	+0.3	+0.8
Northern Plateau	10	0.54	40	−0.8	−1.2
North Pacific	9	1.46	62	−0.9	+4.2
Middle Pacific	5	0.47	82	−0.1	−1.9
South Pacific	4	0.61	555	+0.5	−1.7

Precipitation was unevenly distributed. Torrential rains fell in many places, while drought prevailed in others. The